

## TWO-LAYER CAPACITIVE TOUCHPAD AND METHOD OF MAKING SAME

### BACKGROUND OF THE INVENTION

#### 1. Technical Field

The present invention relates to touchpad pointing devices, and in particular to a touchpad pointing device which is less expensive to fabricate.

#### 2. Summary of the Prior Art

Over the last several years, capacitive touchpad pointing devices have been used extensively in personal computers. When used in conjunction with a computer, a touchpad allows the user to manipulate a graphics cursor on a CRT display. The touchpad comprises a sensitive planar surface and means for detecting the position of an object, such as a finger or a stylus, near or in contact with, the sensitive planar surface. The touchpad continuously communicates this position information to the electronic apparatus, typically at a rate of from 40 to 100 Hz.

Presently, approximately 70% of all new notebook computers include a touchpad as the primary pointing device. In this competitive touchpad market, price has become an increasingly important factor. A touchpad design that is intrinsically less expensive to make has significant commercial advantage.

For reasons to be disclosed below, most existing capacitive touchpad designs are built using a four-layer printed circuit board as the basic structural substrate. The circuit traces on the "top" two (finger-side) layers of the board serve as the capacitive sensing matrix, and the traces on the "bottom", or underside (component-side) layer provide electrical interconnections for the components mounted thereon. The remaining buried layer, the fourth layer, is generally used as a ground plane though it could, in theory, be put to some other use.

While four-layer printed circuit boards are widely available from many manufacturers, it is well-known that they are substantially more expensive than two-layer printed circuit boards of the same size. In large quantities, in excess of 200,000 units per month, a four-layer touchpad-sized printed circuit board with dimensions of, for example, 65 mm by 49 mm might typically cost \$0.80 per unit, with the exact figure depending on many factors. A two-layer circuit board of the same size might cost as little as approximately \$0.40. This savings is substantial when compared to the overall cost of the entire touchpad device. The ability to use a two-layer instead of four-layer circuit board would tend to give a strong competitive advantage to a manufacturer capable of producing such a device.

Two-layer touchpads have been constructed for limited applications. As will be described in greater detail below, these two-layer touchpads require that the controller chip be remotely located on the same circuit board away from the touch sensitive area. Thus, such two-layer touchpads do not perform an equivalent function as do present four-layer touchpads.

### SUMMARY OF THE INVENTION

The subject patent application relates to a capacitive touchpad using a two-layer printed circuit board and method of fabricating it. In particular, an improved touchpad for use in a system for moving a cursor on a display screen is described which includes a printed circuit board having a top and under side, a first layer formed on the top side of the printed circuit board which includes both a plurality of

horizontal sensor electrodes and a plurality of vertical sensor electrodes, and a second layer formed on the underside of the printed circuit board which includes the standard electrical components associated with the touchpad, such as the controller chip and associated interconnect wiring.

In the preferred embodiment the horizontal, or X electrodes are metal traces made by conventional printed circuit fabrication, and are, typically copper. The vertical electrodes are made of conductive ink, such as carbon ink. An insulator is provided at each intersection of a metal trace and a conductive ink trace. This insulator may be a solder mask insulator. An additional protective layer of mylar is provided on top of the first layer.

By suitable use of screen-printed carbon ink patterning, combined with patterning of the solder-mask layer on the top (finger) surface, a compact capacitive touchpad pointing device has been realized using only a 2-layer board as a substrate. The first layer is a single composite layer for both the horizontal and vertical sensor electrode traces; and the second layer, on the underside of the printed circuit board, includes the controller chip, sensor circuitry and/or related circuitry. The present invention is advantageous because it significantly reduces the cost of touchpad devices without adversely affecting their functionality.

### A BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A-1D illustrate a conventional four-layer touchpad.

FIG. 2 is a block, schematic diagram of a prior art two-layer touchpad device.

FIG. 3 is a perspective view of a prior art four-layer touchpad device.

FIG. 4 shows the layout of the top conductive (horizontal) traces for a standard four-layer printed circuit board.

FIG. 5 shows the layout of the second layer with vertical conductive traces.

FIG. 6 shows the vertical carbon ink traces which are applied to the horizontal trace layout, in accordance with the present invention.

FIG. 7 shows the pattern for providing isolation between the horizontal traces and the vertical carbon ink traces, in accordance with the invention.

FIG. 8A is a plan view and

FIG. 8B a cross-sectional view showing details of a composite, two-layer sensor touchpad in accordance with the present invention.

FIG. 9 is a view of the actual underside of a two-layer touchpad showing components attached thereto.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

All four-layer technologies share an important common feature: the finger is detected by a plurality of horizontally-aligned sensor electrodes disposed on a first layer which is separated by an insulator from a plurality of vertically-aligned sensor electrodes disposed on a second layer. Such sensor electrodes are usually formed as standard copper PC board traces. Thus, the sensitive area of the touchpad consists of a 2-layer structure: one layer with horizontally-running electrode traces, and another layer with vertically-running electrode traces.

An example sensor electrode arrangement for a four-layer touchpad is shown in FIGS. 1A-1D. More details of this structure is described in U.S. Pat. No. 5,543,590 entitled